2. ALTERNATIVES

The alternatives section is the heart of this Environmental Impact Statement. This section describes in detail the no-action alternative, the proposed action, and other reasonable alternatives that were studied in detail. Based on the information and analysis presented in the sections on the Affected Environment and the Probable Impacts, this section presents the beneficial and adverse environmental effects of all alternatives in comparative form, providing a clear basis for choice among the options for the decision maker and the public.

2.1. DESCRIPTION OF ALTERNATIVES.

2.1.1. NO-ACTION ALTERNATIVE (STATUS-QUO).

The no-action alternative assumes that current conditions will continue unabated and provides no solution to existing problems. This alternative is considered a viable choice in underdeveloped areas, which do not exist in Broward County, and is used as a gauge by which to measure impacts of suggested alternatives.

2.1.2. REZONING OF BEACH AREA.

Implementation of a construction setback line would result in rezoning the beach area and modifying building codes. This is a viable consideration for reducing storm damages and is a component of the non-structural intermediate alternatives. A construction setback would not effect existing construction and would only be effective as buildings are destroyed by storms and replaced, and buildings constructed on presently undeveloped land. Similarly, a no-growth program would offer no protection to existing structures, which does not meet the goal of the project to provide a reduction in expected storm damage to existing properties.

2.1.3. CONDEMNATION OF LAND AND STRUCTURES.

This alternative would allow the shoreline to erode with associated destruction of property and structures with no plan for protection of existing resources which does not fulfill one of the primary project goals. This alternative allows for the buying of undeveloped shoreline, preventing development, relocating existing structures, and allowing for natural shoreline equilibrium to occur.

2.1.4. REVETMENTS.

Revetments have been placed on severely eroded beaches in the past and provide a temporary solution, while transferring the erosion problem to an adjoining beach. Construction of revetments does not meet several goals of the project, specifically, maintenance of a sandy beach for nesting sea turtles and

the provision of recreational areas and maintenance of the commerce associated with it.

2.1.5. BEACH FILL WITH PERIODIC RENOURISHMENT.

The alternative would allow for beach construction projects of specific dimensions for recreational purposes and to serve as buffers against wave attack. Offshore borrow areas are the considered sources of beach fill, and periodic renourishment would be carried out to maintain the design beach. Sufficient quantities of sand are available in the designated borrow areas for the immediate construction projects, but alternate sources may need to be considered for future projects.

Alternative sources may include distant domestic sand sources within Florida, or possibly outside the state; foreign sand sources, such as the oolitic aragonite sand from the Bahamas; deep water sand sources; and upland sources which contain sand that is texturally comparable to coastal beach sand. Technology is available that allows for dredging deep water sources (up to 300 feet deep); however, no information is available on cost, location, quantity, suitability, or environmental impacts associated with such dredging for the proposed project.

Upland sand quarries are located on the Lake Wales Ridge of the Central Highlands area of south Florida. Two quarries with barge access to the Okeechobee Waterway are located in Ortona, Florida, southwest of Lake Okeechobee (USACE, 1998). Sand would be transported by barge or rail and dump trucks, hauled to the beach, and dumped at designated access sites for redistribution along the beach.

Oolitic aragonite from the Bahamas has been used on a limited basis for a small beach renourishment on Fisher Island, Miami-Dade County, Florida. The USACE Waterways Experiment Station, in consultation with the USFWS, FDEP, and Miami-Dade County Department of Environmental Resources Management, established a sea turtle nesting environmental study in 1995 to explore the potential impacts of foreign carbonate sand on nesting sea turtles. The current studies are being conducted in the Miami-Dade County Sea Turtle Hatchery in Miami Beach using different sand types, including native beach, renourished beach, upland, and aragonite sands (Blair & Henderson, 1998). To date, preliminary findings indicate that there is no statistically significant difference in turtle hatching and emergence in all five sand types, however, differences in sand temperature are sufficient to affect incubation temperature. Incubation periods were longer and nest temperatures were cooler for the nests incubated in aragonite (Blair and Henderson, 1998, Nelson et al., 1996). Until results from this study have been determined, and additional studies and testing have been performed, large scale use of aragonite or other foreign sand on sea turtle nesting beaches is not acceptable to the USFWS and the FDEP (USACE, 1998).

2.1.6. BEACH FILL WITH PERIODIC RENOURISHMENT, WITH STABILIZATION BY OFFSHORE BREAKWATER OR SUBMERGED ARTIFICIAL REEF.

This alternative is considered an option to reduce fill quantities during periodic renourishments as offshore structures may reduce the rate of erosion by minimizing the amount of wave energy impacting the shoreline.

An experimental breakwater shore protection project was constructed in Palm Beach, Florida, in 1993. The Palm Beach breakwater (Prefabricated Erosion Prevention [PEP] reef) consisted of 330 interlocking concrete units (1.8 m H x 3.7 m L x 4.6m W) placed along 1,260 meters of shoreline, and approximately 76 meters offshore. The post-construction monitoring of the submerged breakwater revealed an increase in longshore currents via ponding of water trapped behind the breakwater, which was then diverted alongshore. The annual volumetric erosion rate measured two years after breakwater construction was measured to be 2.3 times higher than the pre-project rate (Browder et al., 1996). Due to this acceleration of shoreline erosion, the PEP reef was removed. Increased erosion associated with offshore breakwater installation does not meet the project goals of maintaining beaches for nesting sea turtles and recreation.

2.1.7. BEACH NOURISHMENT WITH MAINTENANCE MATERIAL FROM UPDRIFT INLET OR SAND BY-PASSING METHODS.

This alternative takes advantage of sand material obtained from maintenance dredging of adjacent inlets, sand transfer plants at inlets or dredge transfers at inlets. The amount and quality of sand obtained from these sources is not always sufficient or acceptable.

Construction of a sand bypassing infrastructure at Port Everglades Inlet would provide an alternative sand source for future maintenance of the Segment III shoreline. Sand bypassing at Port Everglades would provide both physical and economic benefits to the shoreline south of the port and be consistent with current efforts to implement regional sediment at the inlet. The physical benefits include access to a reliable future sand source that is compatible with the native sediments of the Segment III shoreline and reduced sand shoaling within the Port Everglades navigation project. The economic benefits would include reduced maintenance of navigation projects and an overall reduction in the cost to maintain the Segment III project. Due to the insufficient supply of sand related to this alternative, the project goals are not met.

2.1.8. BEACH FILL AND PERIODIC RENOURISHMENT WITH STABILIZATION BY GROINS.

Groins are considered effective in holding beach fill in place and reducing periodic renourishment requirements. A groin field provides a more efficient system than a single groin, since the shoreline exhibits a more smoothed response and the design dimensions are maintained over a greater length of the project.

2.1.9. BEACH FILL DESIGN ALTERNATIVES: MODIFICATION OF BEACH FILL AMOUNTS

Table 1 presents a summary of the fill design evolution for Segment II. The project as defined by the Coast of Florida Study identified a project from Hillsboro Inlet to Ft. Lauderdale which impacted over 20 acres of nearshore hardbottom habitat. The proposed project fill limits in Segment II extended from Pompano Beach (R-35) to Ft. Lauderdale (R-75) with the taper sections included. The impact of this project was not quantified, but was probably between 10 and 15 acres of nearshore hardbottom impact.

The GRR design process resulted in a further reduction in the size of the project. The beach fill length was reduced to the reaches from R-36 to R-43, and from R-51 to R-75. The economically optimized nourishment interval was 13 years which resulted in an impact of 13.1 acres of nearshore hardbottom. Broward County elected to construct a 10-year nourishment interval which reduced fill volume by 150,000 c.y. and impacts to 12.1 acres of nearshore hardbottom.

Using the results of the July 2001 nearshore hardbottom edge survey, the project was subsequently reduced to further reduce avoidable impacts to nearshore hardbottom formations. Superimposing the previous Segment II equilibrium toe of fill showed two areas of continuous impacts: north Pompano Beach (vicinity of R-36) and the south end of Ft. Lauderdale (R-71 to R-74). The Segment II beach was redesigned as follows:

1. North Pompano Beach. Between R-36 and R-42, the volume of advanced nourishment was reduced from 273,000 c.y. to 198,000 c.y. This reduced the probable equilibrium toe of fill impacts to adjacent nearshore hardbottom habitat from 4.5 acres to 3.0 acres of gross impact. No hardbottom will be directly buried at the time of construction.

2. Lauderdale-By-The-Sea and Ft. Lauderdale. In order to avoid equilibrium toe of fill impacts to hardbottom at the south end of Ft. Lauderdale, the

project was shortened by 3,000 feet. Additional fill volume reductions were made near R-52 to eliminate equilibrium toe of fill impacts to adjacent hardbottom communities. The beach nourishment volume of sand was reduced from 887,000 to 737,000 c.y. This reduced the projected equilibrium toe of fill hardbottom impacts from 7.6 acres to 3.0 acres of gross hardbottom impact. No hardbottom will be directly buried at the time of construction.

TABLE 1

SUMMARY OF SEGMENT II BEACH NOURISHMENT DESIGN EVOLUTION

ALTERNATIVE		FDEP LIMITS FDEP Monuments	DESIGN[1] SECTION WIDTH (Feet)	SHORE-LINE LENGTH (Feet)	FILL VOLUME (Cubic Yards)	ETOF IMPACTS[2] (Acres)
COFS Recommendation						
	Pompano Beach/LBTS	R-25 to R-53	35	28,000	600,000	12.25
	Ft. Lauderdale	R-53 to R-74	25	21,100	792,000	8.1
	TOTAL			49,100	1,392,000	20.35
Initial Submittal to Agencies (Nov. 1999)						
	Pompano/LBTS	R-35 to R-75	100	39,800	1,800,000	Not
	Ft. Lauderdale		25			Quantified[3]
	TOTAL		125			
						(based upon 1999 conditions)
GRR 2001 (Based upon 1999 conditions)						
	Pompano/LBTS	R-36 to R-43	100			
	Ft. Lauderdale	R-51 to R-75	25			
	TOTAL		125			
	13-Yr Nourishment			30,900	1,362,000	13.1
	10-Yr Nourishment Interval			30,900	1,214,000	12.1
GRR 2001 (Based upon 2001 conditions)						
	Pompano/LBTS	R-36 to R-43	100			
	Ft. Lauderdale	R-51 to R-75	25			
	TOTAL			30,900	935,000	
Revised Plan that Reflects Final Avoid and Minimize Analysis						
GRR 2002 (Based upon 2001 conditions)						
	Pompano/LBTS	R-36 to R-43	100			6.0 gross
	Ft. Lauderdale	R-51 to R-72	20			2.5 net[4]
	TOTAL		120	27,900	935,000	
	6-Yr Nourishment Interval					

Notes:

(1) Design width is measured from the Erosion Control Line. In Pompano Beach/LBTS, the design beach is currently in place.

(2) ETOF is the Equilibrium Toe of Fill.

(3) While no specific area of impact was quantified, the Segment II total was estimated between 10 and 15 acres.

(4) ETOF is predicted to cover approximately 6.0 acres of nearshore habitat (hardbottom and unconsolidated sediments) during equilibration of the beach fill. An estimate of hardbottom extent was obtained by review of the shore parallel video transect documentation obtained in 2001. During video evaluation, areas of significant sand pockets interspersed in the hardbottom platform were excluded from the original estimate of hardbottom acreage within the ETOF. The net area of impact will be 2.5 acres of actual hardbottom within the ETOF. The remainder is sand bottom.

A comprehensive evaluation of the shore parallel video transects documented in 2001 differentiated between hardbottom habitat and areas of unconsolidated sediments (sand patches) occurring between the landward edge of the hardbottom platform and the ETOF. The evaluation documented that within the impact area, 3.5 acres of sand and unconsolidated sediments exist. Therefore, of the gross total area of 6.0 acres within the Segment II ETOF, 2.5 acres of hardbottom habitat represents the net nearshore hardbottom habitat impact within this reach. These impacts represent approximately 0.2% of the hardbottom habitat documented in the 10 to 17 foot depth range adjacent to the Segment II project area. The laser bathymetric survey data (LADS) estimated that the nearshore hardbottom tract extends from –10 to –34 feet (NGVD) and covers approximately 5,000 acres.

Table 2 presents the fill design evolution for Segment III. Similar to the design process for Segment II, the July 2001 nearshore hardbottom edge was used to reevaluate probable project impacts. Superimposing the Segment III equilibrium toe of fill included in the January 2001 GRR on the hardbottom mapped during field investigations showed that the probable impacts increased from 6.3 to 10.4 acres in John U. Lloyd State Park, and decreased from 6.5 to 2.7 acres in Hollywood/Hallandale. The increase in impacts in John U. Lloyd State Park was due to continued high erosion rates in this area and the associated exposure of nearshore hardbottom. Probable impacts decreased in Hollywood/Hallandale due to an apparent redistribution of the natural variations in nearshore hardbottom coverage throughout the area. Overall, there was an increase of approximately 0.4 acres of nearshore hardbottom impact. As a result, the Segment III project was further modified for the purposes of avoiding and minimizing these impacts. The beach was redesigned as follows:

1. John U. Lloyd. Between R-86 and R-95.5, the design beach was eliminated and the advanced nourishment was redistributed to minimize nearshore hardbottom impacts while providing the required advance fill volume necessary for the six-year renourishment interval. A smaller advance fill volume was not considered due to the potential for adverse impacts associated with high frequency dredging activities. In sum, 295,800 cubic yards of fill were deleted from the John U. Lloyd State Park project. This reduced the projected equilibrium toe of fill impacts to adjacent nearshore hardbottom from 10.4 to 5.0 acres. These impacts are considered unavoidable due to constructability and minimum performance criteria. It is expected that there will be direct burial of 0.9 acres at the time of construction.

TABLE 2

SUMMARY OF SEGMENT III BEACH NOURISHMENT DESIGN EVOLUTION

ALTERNATIVE		FDEP LIMITS FDEP Monuments	DESIGN SECTION WIDTH (Feet)	SHORE-LINE LENGTH (Feet)	FILL VOLUME (Cubic Yards)	ETOF[1] IMPACTS[2] (Acres)
COFS Recommendation						
	John U. Lloyd	R-86 to R-98	100	10,900	1,032,000	
	Dania	R-98 to R-101	50-100	3,200	406,840	
	Hollywood/Hallandale	R-101 to R-128	50	28,700	720,000	
	TOTAL			42,800	2,158,840	>20
Initial Submittal to Agencies (Nov. 1999)						
	John U. Lloyd	R-86 to R-98	50	10,900	800,000	
	Dania	R-98 to R-101	50	3,200	400,000	
	Hollywood/Hallandale	R-101 to R-128	50	28,700	1,000,000	
	TOTAL			42,800	2,200,000	>20
						(based upon 1999 conditions)
GRR 2001 (Based upon 1999 conditions)						
	John U. Lloyd	R-86 to R-96	50	9,200	618,700	6.3
	Hollywood/Hallandale	R-99 to R-128	50	30,300	1,151,300	6.5
	TOTAL			39,500	1,770,000	12.8
GRR 2001 (Based upon 2001 conditions)						
	John U. Lloyd	R-86 to R-96	50	9,200	735,000	10.4
	Hollywood/Hallandale (taper in Dania)	R-99 to R-128	50	30,300	1,238,000	2.7
	TOTAL			39,500	1,973,000	13.1
						plus 1.1 acres of worm rock as mapped in detail in 2001[3]
Revised Plan that Reflects Final Avoid and Minimize Analysis						
GRR 2002 (Based upon 2001 conditions)						
	John U. Lloyd	R-86 to R-92	0	6,200	440,000	5.0
	Hollywood/Hallandale (taper in Dania)	R-99 to R-128	50	30,300	1,100,000	1.5
	TOTAL			36,500	1,540,000	6.5
						plus 1.1 acres of worm rock as mapped in detail in 2001[3]

[1] ETOF is the Equilibrium Toe of Fill.

[2] Gross and net impacts in Segment III are identical.

[3] An additional 1.1 acres of nearshore wormrock (*Phragmatopoma lapidosa*) habitat will be impacted in Hollywood/Hallandale. A 1999 survey of this area suggested that this area was over 3.5 acres. The area was resurveyed in October 2001 using highly detailed field surveying methods. The 2001 survey revealed approximately 0.1 acre of solid wormrock reef and 1.0 acre of unattached, wormrock rubble that varies in density from 5 to 100 percent coverage (see Figure 10). In total, the wormrock area represents approximately 1.1 acres of hardbottom habitat. This is the only hardbottom area that will be directly buried at the time of construction in Hollywood/Hallandale.

2. Hollywood/Hallandale. Additional fill volume reductions have been made throughout the Hollywood/Hallandale project reach to avoid and minimize nearshore hardbottom impacts. Overall, the scope of the Hollywood/Hallandale project is essentially the same as stated in the January 2001 GRR. The principal change in the project design is the elimination of a minimum fill section requirement of 20 cy/ft. This requirement was originally included for project constructability purposes. Further coordination with the dredging industry, however, indicates that a minimum sectional volume may not be necessary to construct the project. Therefore, for the purposes of minimizing project fill volumes and associated nearshore hardbottom impacts, Broward County elected to not include a minimum fill section requirement. As a result, fill will only be placed as needed to accommodate project performance requirements. The volume of sand to be placed along the Hollywood/Hallandale reach has been reduced from 1,238,000 to 1,100,000 cubic yards. This reduced the probable equilibrium toe of fill hardbottom impacts from 2.7 to 1.5 acres.

To summarize, the Segment III beach fill volume was reduced to 1,540,000 cubic yards and the associated probable hardbottom impacts are expected to be 7.6 acres, which includes 6.5 acres of nearshore hardbottom and 1.1 acres of wormrock and wormrock rubble. The acreage values are equal for both net and gross nearshore hardbottom impacts for Segment III. These impacts represent approximately 0.1% of the nearshore hardbottom area in Segment III. The LADS survey estimated that the nearshore hardbottom extends from about -5 to –34 feet (NGVD) between the beach and the first reef tract offshore, covering approximately 5,200 acres.

2.1.10 SEAWALLS.

Maintenance of existing bulkheads/seawalls or construction of additional concrete structures would provide a significant degree of protection to upland structures at the expense of recreational beaches. Hazardous bathing conditions, including undertow and runouts, are created by steep offshore profiles due to accelerated wave energy reflecting off seawalls. Therefore, construction of seawalls does not meet the project goals of maintaining sufficient beach for nesting sea turtles or recreational opportunities and the commerce associated with those opportunities.

2.1.11 BEACH FILL WITH PERIODIC RENOURISHMENT AND HURRICANE SURGE PROTECTION SAND DUNE.

This alternative would provide protection to the shoreline and existing structures from storm surge flooding and wave run-up. Construction of a high elevation dune is generally not Federally authorized, economically justifiable, aesthetically pleasing, or socially/environmentally acceptable and does not fulfill the project goals as stated in Section 1.4.

2.1.12 BEACH NOURISHMENT WITH CREATION OF NEARSHORE BERM FROM MAINTENANCE MATERIAL FROM ADJACENT INLET.

Improved dredging technology allows for placement of dredged material in offshore shallow water rather than along the beach area. This alternative provides lower costs than onshore placement, but has potential impacts to nearshore hardbottom areas. The potential impacts to nearshore hardbottom resulting from this alternative do not meet the project goals.

2.1.13 STABILIZATION OF BEACHES AND DUNES BY VEGETATION.

This alternative provides for planting of beach grasses and construction of sand fences to provide stability to the dune area at the loss of some recreational beach area. There are no natural dunes remaining in the study area. Therefore, this alternative cannot be implemented in a manner that meets the stated project goals.

2.1.14 MODIFY NAVIGATION PROJECT.

This alternative provides for modification of inlet jetties, sand transfer facilities, channel alignments and/or inlet closure to improve efficiency in the maintenance of navigation areas. Reduction in shoreline erosion will not result from implementation of this alternative which does not satisfy the project goals.

2.1.15 SAND TIGHTENING OF JETTIES.

Sand tightening decreases permeability of the jetties and decreases sand transport away from beaches and into inlets. This decreases maintenance dredging requirements. As part of the 1989 renourishment of John U. Lloyd State Park, the south jetty at Port Everglades Inlet was grouted as a measure to reduce the sand loss rate from the northern John U. Lloyd shoreline. Although the jetty sand-tightening most likely reduced the sand loss rate to the inlet, the shoreline immediately downdrift of the inlet continued to erode more or less at historic rates. Therefore, additional sand tightening measures will not reduce the erosion rates present within the project areas and do not fulfill the project goals.

2.2. ISSUES AND BASIS FOR CHOICE.

Alternative selection process involves the identification and preliminary assessment of possible solutions. Several alternatives were not evaluated further than the initial screening due to a combination of economic viability, effectiveness, and/or political or social acceptance (USACE, 1996). Those alternatives deemed possible were compared with cost estimates and benefits, and discussion of potential environmental impacts. Suggested alternatives should include computation of cost code of account-level cost estimates, including costs of lands, easements, rights-of-way, and mitigation, as well as Federal and non-Federal cost allocations.

2.3. PREFERRED ALTERNATIVE(S).

The preferred alternative involves beach fill with periodic renourishment with initial fill placement of approximately 2.5 million cubic yards of material along 11.8 miles of Broward County shoreline. Beach fill amounts have been modified to minimize the coverage of nearshore hardbottom habitat. In Segment II (Hillsboro Inlet to Port Everglades), fill will be placed along beaches in southern Pompano Beach, Lauderdale-By-The-Sea, and northern Fort Lauderdale. In Segment III (Port Everglades to the south County line), fill will be placed in John U. Lloyd State Park, Hollywood, and Hallandale. In the southern portion of John U. Lloyd State Park and north Dania Beach, fill placement was eliminated during the design process to minimize nearshore hardbottom impacts. Berm elevations will range from +7 feet (NGVD) to +10 feet (NGVD) depending upon location. The project will result in a design mean high water extension of 100 feet, 20 feet, 0 feet, and 50 feet in Pompano Beach, Lauderdale-By-The-Sea, Ft. Lauderdale, John U. Lloyd State Park, and Hollywood/Hallandale, respectively. Additional advanced nourishment, overfill, and terminal transition fill will be placed.

Fill will be obtained from five discrete borrow areas located between hardbottom areas offshore of the central and northern portion of the County. The borrow areas are located from 0.3 to 0.9 miles offshore in water depths ranging from 30 feet to 70 feet. Rocks contained in the borrow material will be segregated on the hopper dredge and deposited in two offshore rock disposal areas. The proposed northern rock disposal area is located approximately 2 miles offshore of Hillsboro Beach in approximately 380 feet of water. The southern rock disposal area is located approximately 2 miles offshore of Hollywood in approximately 200 to 350 feet of water. The rock disposal areas were investigated using a remotely operated vehicle (ROV), and do not contain any hardbottom biological communities. Geotechnical investigations have determined that the sediments in the borrow areas are generally compatible with existing beaches and contain an average of 2.6% silt and 6.4% rock.

2.3.1. HILLSBORO INLET TO PORT EVERGLADES (SEGMENT II).

Segment II of the Broward County, Florida Shore Protection Project extends from Hillsboro Inlet to Port Everglades. The proposed project will renourish south Pompano Beach and Lauderdale-By-The-Sea; and restore the beaches of northern Fort Lauderdale for the first time. Fill will be placed to establish a design mean high water extension of 100 feet and 20 feet in Pompano Beach/Lauderdale-By-The-Sea and Fort Lauderdale, respectively.

The project is based on the Coast of Florida Study (USACE, 1996) updated to 2001 conditions. The project fill area is 4.9 miles long and extends from SE 6th Street in Pompano Beach (FDEP monument R-36) to 1620 S. Ocean Blvd. (R-43), and from 300 feet south of Commercial Blvd. (R-51) to Auramar Street in Ft. Lauderdale (FDEP monument R-72). The new beach will have a berm

elevation of 9.0 feet (NGVD) and will require 935,000 cubic yards of sand fill dredged from five offshore borrow sites. The borrow areas are located between Deerfield Beach and Lauderdale-By-The-Sea and are 0.3 to 0.9 miles offshore.

2.3.2 PORT EVERGLADES INLET TO DADE COUNTY LINE (SEGMENT III).

Segment III of the Broward County Shore Protection Project is located between Port Everglades and the Broward/Dade County line. The fill area in Segment III is 6.9 miles long. The area includes the John U. Lloyd State Park, Dania Beach, and Hollywood/Hallandale shorelines. To date, both the Hollywood/Hallandale shoreline and a portion of the John U. Lloyd State Park shoreline have been nourished. The Dania Beach shoreline and the southern section of the John U. Lloyd State Park shoreline have never been improved by sand placement. No beach fill will be placed between FDEP monuments R-92 and R-99 in John U. Lloyd State Park/Dania Beach.

The proposed project will provide for beach nourishment of the majority of the Segment III shoreline. Fill will extend from Port Everglades (R-86) to R-92 within John U. Lloyd State Park, and from the Dania Beach pier (R-99) to the Dade County line (R-128). The estimated sand fill volume for Segment III is approximately 1.54 million cubic yards. The proposed source of the sand fill will be from borrow sites located offshore of northern Broward County. The resulting equilibrated beach width is expected to average about 60 feet at the mean high water line. It is noted that extensive areas of nearshore hardbottom exist along the entire Segment III project shoreline. Project redesign has minimized impacts to these hardbottom areas, and biological characterizations of the impacted nearshore hardbottom determined the mitigatability of this habitat.

The Segment III project will also include the construction of three shore stabilizing structures (two T-head groins and a jetty spur) along approximately 700 feet of shoreline immediately downdrift of the Port Everglades entrance. Previously, two sand fill projects were constructed along the northern John U. Lloyd State Park shoreline. Due to localized high erosional forces along this shoreline, both of these projects have been unsuccessful in maintaining a suitable protective and recreational beach. The purpose of the groins is to maintain the design shoreline at this location and minimize sand losses to the Port Everglades Entrance channel. The shore stabilizing effects of the structures reduce the advanced nourishment requirement necessary to maintain the design beach. Therefore, only a limited volume of advance fill will be placed within the limits of the structure field.

The groins will be of rubble mound construction and will include a T-head at the seaward end. The spacing between the groin stems is approximately 280 feet, and the distance between the T-heads is about 150 feet. Once the sand fill between the groins equilibrates, the seaward limit of the groins will be situated about 60 to 80 feet eastward of the design mean high water shoreline. The

groins and associated design beach are not expected to impact any nearshore hardbottom or seagrass areas. It is anticipated that future sand bypass activities being investigated at the Port Everglades entrance will result primarily in sand placement south of the groin field.

An additional component of the Segment III project will be the future establishment of a sand bypassing facility at Port Everglades. A detailed study to evaluate the physical, economic, and socio-political feasibility of implementing sand bypassing at Port Everglades is currently being conducted by Broward County and will be completed in the spring of 2003. If determined feasible, sand bypassing at Port Everglades will be used as an alternate sand source for future maintenance of the Segment III Shore Protection Project. It is anticipated that the sand bypassing program will include at least the establishment of a sand collection area north of the inlet, and sand pumping and discharge infrastructure along the shoreline south of the inlet. The methods for collecting and transferring sand across the inlet will be evaluated in detail by the feasibility study. The principle methods that will be considered include (1) an interception system with a fixed plant with a dedicated pipeline and (2) a storage system with a deposition basin that will be maintained by conventional dredging equipment on a regular basis. It is anticipated that bypassed sand will be discharged along the south shoreline within 3,000 feet of the south jetty.

2.4. ALTERNATIVES ELIMINATED FROM DETAILED EVALUATION.

With the exception of the no-action plan, all non-structural alternatives were eliminated from detailed evaluation because they do not meet the stated goals of the project as defined in Section 1.4. Seawalls were not considered to be acceptable because they function only to protect upland property that is already well armored. Creation of nearshore berms demonstrated increased potential for negative impacts to nearshore hardbottom areas due to placement of dredged material in offshore shallow water. The structural alternatives for detailed evaluation include beach fill with periodic nourishment using offshore sand sources; beach fill with periodic nourishment using alternative sand sources; and beach fill with periodic nourishment with stabilization by groins in the erosional hot-spot immediately downdrift of Port Everglades Inlet.

2.5. ALTERNATIVES NOT WITHIN JURISDICTION OF LEAD AGENCY.

Alternatives 2.1.2. Rezoning, and 2.1.3. Condemnation, are not within the jurisdiction of the lead agency and would be exercised by the local sponsor if deemed feasible.

2.6. COMPARISON OF ALTERNATIVES.

Table 3 summarizes the major features and consequences of the net impacts of the proposed combination of alternatives. Refer to Section 4.0 Environmental Effects for a more detailed discussion of impacts of alternatives.

2.7. MITIGATION.

Mitigation plans are summarized in Table 3. Under the recommended plans, mitigation measures would be required for: (1) impacts to sea turtles due to nourishment activities; (2) impacts to sea turtles due to groin construction; (3) impacts to sea turtles, manatees and right whales associated with dredge operations; (4) impacts due to placement of sand fill adjacent to or on nearshore hardbottom; (5) impacts to hardbottom communities due to increased turbidity or sedimentation from nourishment activities; and (6) impacts to hardbottom communities by mechanical damage, increased turbidity and sedimentation at the borrow areas. Discussion of mitigation measures can be found in the mitigation section of each impacted resource. A monitoring plan for nearshore hardbottom impacts and a reef edge sedimentation monitoring plan for assessment of sedimentation impacts adjacent to the borrow areas are included in Appendices E and F.

Table 3: Comparative Impact of Alternatives and Proposed Mitigation for Impacts

ENVIRONMENTAL FACTOR	No-Action Impacts	Net Impacts of Proposed Combination of Alternatives	Mitigation for Proposed Combination of Alternatives
PROTECTED SPECIES	Sea turtle nesting areas would continue to decrease as beaches erode; continual erosion into the dune areas during storm events may threaten endangered dune species.	Sea turtle nesting areas would increase in areas with nourishment activities; approximately 69 additional acres of beach would be created at equilibrium; potential for incidental "take" of sea turtles from sand deposition, over-compaction of nourished beaches, unnatural escarpments, and equipment lighting and dredge operations; possible encounters with the West Indian Manatee with support boats for dredge operations; possible but insignificant impacts to endangered dune species from increased tourism associated with beach nourishment; possible but unlikely encounters with the right whale from dredge operations. Proposed groins at John U. Lloyd State Park may negatively impact sea turtle nesting and hatching success. Approximately 10.1 acres of nearshore hardbottom habitat which serves as foraging habitat for juvenile sea turtles will be impacted by beach fill equilibration.	General mitigation actions are discussed herein. Nourishment Areas: Activities would be conducted outside of sea turtle nesting season in areas of high density nesting; 65 day pre-construction nest survey and relocation conducted between sunrise and 10 am; nourished beaches would be monitored for the 500 PSI compaction limit and tilled to 36 inches; escarpments greater than 18 inches and 100 feet long would be leveled; lighting on equipment would be screened/shielded. Nearshore Hardbottom: Foraging habitat for juvenile green turtles (macroalgae and turf algae impacts) will be mitigated by placement of limestone boulders in nearshore sand pockets and monitored for macroalgal recruitment (See Appendices E&F). Borrow Area/Dredging: Should hopper dredging be utilized, a rigid draghead deflector would be used, inflow and outflow screening would be required, shipboard observers for both sea turtle and whale identification would be required, and the policy of dredge pumps remaining disengaged when dragheads are not firmly on bottom would be observed. Whale observers would be used as appropriate; signs would be posted on crew vessels and work stations informing the crew of possible whale and manatee encounters; no-wake speeds would be observed at all times in shallow waters; and logs of encounters for all species would be kept for USFWS or NMFS.

HARDGROUND	Additional nearshore hardgrounds would become exposed.	Burial of a net total of approximately 2.5 acres of nearshore hardgrounds in Segment II, and approximately 7.6 acres in Segment III, including direct burial of 0.9 acres of nearshore hardbottom in John U. Lloyd State Park and 1.1 acres of wormrock habitat in Hollywood. Potential for mechanical damage to hardgrounds adjacent to borrow area operations and along pipeline corridors. Potential for temporary turbidity and sedimentation impacts around borrow area operations, potential for secondary impacts to nearshore hardbottom communities adjacent to the equilibrium toe of fill resulting from sedimentation and/or chronic turbidity.	Mitigation of nearshore hardgrounds will be accomplished by placement of 11.9 acres of large limestone boulders. Boulders will be individually placed in large groups across sandy areas of the nearshore zone. Mitigative nearshore reefs are planned for construction in spring/summer of 2003, from April 1 through September 30. Areas not completed in 2003 will be completed in 2004, but it is anticipated that all deployments will be completed in 2003, prior to fill placement. Project specific mitigation plans are included in Appendix F.
SHORELINE EROSION	Shoreline would continue to erode at its present rate	Would maintain a high quality recreational and storm protective beach.	None.

FISH AND WILDLIFE RESOURCES	No anticipated impacts to soft bottom communities. No anticipated impacts to fish communities. Potential for additional exposed nearshore hardgrounds to provide habitat for nearshore fish community. Continual erosion into the beach/dune areas would decrease habitat for dune species and migratory birds.	Likely major, but short-term infaunal diversity changes in the nearshore and offshore softbottom areas associated with borrow operations and fill placement. Temporary infaunal diversity changes at beach fill placement sites. Migratory birds may be temporarily discouraged from using areas during construction activities and would relocate to other areas away from anthropogenic activity. The proposed alternative would affect an estimated 10.1 acres of nearshore hardbottom habitat that is designated EFH for coastal migratory species, and the snapper-grouper complex (EFH-HAPC). Burial of nearshore hardbottom may cause relocation of motile faunal populations, reductions in feeding success and recruitment of juvenile fish, and mortality of demersal fish species by direct burial of 2.0 acres of nearshore hardbottom.	Burial of nearshore hardbottom will be mitigated for by placement of 11.9 acres of limestone boulders in nearshore reef sand pockets. Mitigation details for impacts to EFH are provided in the proposed mitigation plan included in Appendix F.
VEGETATION	No natural dunes exist in project area. Existing dune vegetation could be impacted, and possibly lost in some areas, if no action is taken. No anticipated impacts to seagrass beds due to the no-action alternative.	Dune vegetation: Density of existing dune grass species would increase in areas where planting occurs. Increased shoreline width would better protect dune communities during storm activities. Seagrasses: secondary impacts of turbidity should not be a major concern due to relatively low silt contents in adjacent borrow areas and tidal flushing. Minor temporary impacts are possible during dredging. No direct impacts are anticipated.	Dune vegetation- no mitigation proposed. Seagrass impacts- no mitigation anticipated.
WATER QUALITY	Assumed no turbidity impacts to water quality.	Temporary increases in turbidity adjacent to both the borrow sites and the nourishment zones, with lower turbidity associated with hopper dredging.	None.

HISTORIC PROPERTIES	No anticipated effects.	Potential, but unlikely, impacts to undocumented submerged archaeological sites. Magnetometer surveys, archaeological SCUBA dives, and ROV video investigations of the original seven, proposed borrow areas revealed only one known submerged cultural resource, the bow section of the *S.S. Copenhagen*, in the immediate vicinity of the borrow areas.	Consultation with SHPO resulted in the requirement of a 300-foot buffer around the center of the *S.S. Copenhagen* for protection during dredging operations.
RECREATION	Continued shoreline recession with corresponding decreases of beach area; likely increases of hardground diving areas in nearshore environment.	Estimated 69 acres of new beach would be created in Broward County. Equipment and crews would temporarily deter beach activities in the area during beach construction; temporary increases in turbidity may degrade snorkeling and diving experiences around borrow and nourishment areas.	None.
AESTHETICS	Aesthetic impacts associated with unabated beach erosion; landward advancement of surf zone.	Temporary aesthetic impacts associated with construction activities.	None.
NAVIGATION	No impacts to navigation associated with the no-action alternative.	Temporary impacts to navigation associated with construction activities in the borrow areas and beach fill site	None.
ECONOMICS	Continued erosion of existing beach would result in increased potential of storm damage, increased energy requirements associated with post-storm clean-up activities, and a likely reduction in beach-associated tourism revenues, property tax revenues, and jobs.	The total annualized storm damage and land loss reduction benefits in Segment II are $25.5 million; in Segment III, $13.3 million. The total annualized recreational benefit in Segment II is $9.1 million, in Segment III, $12.7 million. No permanent impacts on commercial or recreational fishing are expected. Bell and Leeworthy (2002) found that even when environmental impact costs are included in the evaluation, the economic benefits from the project far exceed the costs.	None

ENERGY REQUIREMENTS AND CONSERVATION	Energy requirements associated with clean-up after storm events would continue to increase concurrent with realized damages	Insignificant energy requirements for beach project construction. Possible permanent operation of a sand transfer plant at Port Everglades Inlet would involve increased energy requirements.	None.
COASTAL BARRIER RESOURCES UNIT	No anticipated impacts.	Two parcels near Dania beach are listed as undeveloped coastal barriers as defined by the Coastal Barriers Resources Act, which require coordination with USFWS prior to nourishment activities to identify any potential impacts.	Coordination with USFWS must be accomplished for any nourishment activities.